

S
639.9
F2eses
1981

Date Due

APR 6 - 1994

SEP 23 1998

JAN 9 2008

APPENDIX

EFFECTS OF SEISMIC EXPLORATION
ON SUMMERING ELK IN THE
TWO MEDICINE - BADGER CREEK AREA,
NORTHCENTRAL MONTANA

STATE DOCUMENTS COLLECTION

1 JUL 15 1994

MONTANA STATE LIBRARY
1515 E. 6th AVE.
HELENA, MONTANA 59620

Gary Olson
Montana Department of Fish, Wildlife, and Parks
December, 1981

PLEASE RETURN



TABLE OF CONTENTS

Abstract	1
Introduction	2
Description of Study Area	2
Literature Review	5
Methods	7
Results	9
Discussion	19
Literature Cited	23



List of Figures

Fig. 1	Study Area	4
Fig. 2	Elk 4-1 under effects of drug. Glacier National Park in background	7
Fig. 3	Various locations of elk 4-1 showing seismic lines.	10
Fig. 4	Upper South Fork Two Medicine River.	11
Fig. 5	Hyde Creek drainage and Two Medicine Ridge	12
Fig. 6	Various locations of elk 4-7 showing seismic lines.	13
Fig. 7	Continental Divide at head of Lee and Sydney Creeks.	14
Fig. 8	Various locations of elk 4-6 showing seismic lines.	15
Fig. 9	Various locations of elk 3-8 showing seismic lines.	17
Fig. 10	Movements of two cow elk in relation to seismic activity	21

List of Tables

Table 1	Trapping and tagging information on Two Medicine elk.	8
Table 2	Comparison of elk movements on two different summer ranges in relation to seismic activity	18



Abstract

Four radio collared cow elk were monitored throughout the spring, summer, and fall, 1981, to assess the effects of geophysical exploration on their distribution in the Badger Creek - South Fork Two Medicine River area of north-central Montana. For comparison, movements of two radio collared elk summering in the Middle Fork Flathead drainage (where no seismic activity took place) were also monitored.

Seismic methods employed were mainly surface blasting with one line by porta-drill. Helicopters were used to transport men and equipment. A total of seven seismic lines were surveyed through the study area during August, September, and October by Seisdata Services, Inc., SEFEL Company, and Mountain Geophysical Corporation.

As helicopter and blasting activity proceeded eastward, elk generally began moving back into the drainages occupied before exploration began. No locations were noted in direct line of sight of seismic work, rather the elk preferred to remain at least one ridge or drainage from the disturbance, mostly in heavy timber cover.

Based on average distances moved between flights for radio collared elk along the Middle Fork Flathead River in the Great Bear Wilderness, the Two Medicine group moved at least 50% more between observations.

Another collared elk which summered in Glacier National Park moved over a steep pass into an adjacent drainage approximately the same time as seismic work began in the South Fork Two Medicine valley. Her average movements between locations for the summer-fall period were much the same as the Middle Fork Flathead elk.

Levels of activity in winter similar to that of this summer may cause severe physiological stress on the South Fork Two Medicine herd. Forced movements to marginal winter range may disrupt reproductive processes and nutritional balances. The net effect could be calf losses and death of weaker segments of the herd structure.

Recommendations for future seismic activity in this area are:

1. Eliminate activity on occupied winter range from November 1 - May 15.
2. Prevent disturbances in known calving and spring migration zones from May 1 - July 1.
3. Designate specific travel routes, no more than 1/2 mile wide, for aircraft and work crews to minimize "cut across" traffic between lines. Helicopters in flight should maintain a 500 foot elevation above valley bottoms, sideslopes, and passes. Bighorn sheep and mountain goat concentration areas should be avoided altogether.
4. Maintain a distance of one main drainage or three tributary drainages between concurrent seismic lines. Lines running perpendicular to the direction of drainages could be handled in a manner which would allow at least 5 miles between concurrent lines.



Introduction

Early in the spring of 1981 three elk (*cervus elaphus*) were collared with radio transmitters on winter range along the South Fork Two Medicine River. The radio telemetry study was initiated in order to assess the effects of geophysical exploration on summering elk in the Badger Creek-Two Medicine drainages. A portion of the funding was provided by the Rocky Mountain Ranger District, Lewis and Clark National Forest, with the remainder by Montana Department of Fish, Wildlife, and Parks. In addition, movements of two radio collared elk were monitored on summer range along the Middle Fork Flathead River (Great Bear Wilderness) where no seismic activity occurred.

The scope of the study was limited to actual movements of elk from the time they were collared through the general hunting season of 1981. Up to this time there had been no intensive studies of the Badger-Two Medicine elk herd. Tracking of elk occurred from fixed wing aircraft and on the ground with portable receiving equipment. Locations were plotted on 7.5 minute topographic maps. Seismic data such as line locations and dates of activity was provided by Lewis Young, Wildlife Biologist, Rocky Mountain Ranger District.

Hydrocarbon extraction and development along the Rocky Mountain Front are quite likely, as evidenced by the intense interest oil and gas companies have shown in the leasing of minerals and seismic exploration. Wildcat discoveries of natural gas in the Blackleaf area, (30 miles southeast of the Badger-Two Medicine study area) in late 1980 intensified seismic exploration and leasing interest on National Forest lands along the Front in 1981, when approximately 190 miles of lines were surveyed. Three companies operated in the Badger-Two Medicine area during August, September, and October for a total of 48 miles of seismic lines.

Description of Study Area

The Badger Creek-Two Medicine River Study area (Fig. 1) is bounded by Highway 2 and Glacier National Park on the northwest, by the Blackfoot Indian Reservation on the east and north, by Birch Creek on the southern end, and by the Continental Divide on the west. The area contains some 123,000 acres of National Forest with 2,800 acres private (Schallenberg 1974).

Elevations in this mountainous terrain vary from 8,385 foot Morningstar Mountain to 4,653 feet on lower Badger Creek, near the National Forest boundary.



Weather records for the area reveal a mean annual precipitation of around 40 inches, approximately 60% of which falls as snow during November through April. The mean monthly temperature is 36° F, with extremes of -40° F in the winter to 90-100° F in late summer. Strong westerly winds often contribute to the "chinook" effect that is common along the Rocky Mountain Front.

Birch Creek, Badger Creek, and the South Fork Two Medicine River all drain in an easterly direction toward the Blackfoot Indian Reservation. These river valleys are generally U-shaped with a flood plain and sideslopes that are heavily timbered and dotted with moist open meadows.

Wintering elk concentrate in the lower Two Medicine and Badger Creek area, as well as open south and west facing slopes along tributary streams. Lubec Ridge and Two Medicine Ridge are also heavily used, especially during the mild winters. Summering areas include Two Medicine Ridge and beyond to high valleys beneath the Continental Divide, however, a portion of the winter herd apparently moves across U.S. Highway 2 into Glacier National Park for the summer and fall months.

Fires in 1889 and 1910 burned a majority of the study area. Today widespread aspen and lodgepole pine stands verify the fire record and indicate an early successional vegetative phase.

The Two Medicine-Badger unit contains 174 miles of trails as well as 34 miles of former primitive seismograph roads; there are 26 miles of roads including about 8 miles of U.S. Highway 2 (Schallenger 1974). The main line Burlington Northern track lies adjacent to Highway 2.

Seismograph roads were constructed in the area during 1955-57 with extensive seismic activity in the 1960's. These roads provided convenient routes of travel with the advent of the snowmobile. Many feel that the roads combined with four-wheel drives and snowmobiles increased illegal hunting, especially during the winter and spring. Two of the main roads were closed in October, 1972, but snowmobile activity persists. Year round hunting, especially on snowmobiles, greatly impacts wintering elk and moose. Several outfitters and hunters utilize the Badger-Two Medicine area for elk and bear hunting. The present five week season allows one week of either sex elk hunting, with the remainder antlered bulls. Approximately 50 animals per year are harvested in Hunting District 415, of which Badger Creek and South Fork Two Medicine are the primary elk habitat.



R 13 W

R 12 W

R 11 W

Fig. 1. Location map showing seismic lines and landing zones.





Hunter success varies annually with weather conditions, averaging 11%. Periodic winter flights are conducted by Department of Fish, Wildlife and Parks personnel to get population numbers as well as annual production.

Homesteads were established within the National Forest about 1910; several of these area still inhabited year round. In 1909, 8,000 sheep were authorized on the South Fork Two Medicine-Badger Creek. Cattle were also allowed on the Forest at this time. At present about 600 head of cattle and 1000 sheep are allowed to graze on this portion of the Forest.

Literature Review

Even a very superficial review of work done on elk, roads, and human disturbance indicates that line of sight barriers are important as elk move away from the source of the disturbance. Avoidance of roads by elk has been documented by several researchers, Roberts 1974, Black et al. 1975, Gruel and Roby 1975, Ward 1975, Hershey and Legee 1975, Marcum 1975, Basile and Lonner 1979, Lyon 1979, Rost and Baily 1979, and Montana Cooperative Elk-Logging Study 1981.

Perry and Overly (1977) found that roads in the Blue Mountains of Washington significantly reduced both elk and deer distribution in meadow habitat. South and west slopes were used to a greater extent and therefore roads in these areas were particularly detrimental. Lonner (1981) states that when man alters the environment in which elk live individual elk or groups of elk usually remain on their established home range but will use it differently. The larger the home range area altered and the faster the rate of alternation the more tenuous the elk use of that area becomes. Morganti (1979) studying big game in western Alberta found that learned avoidance of human activities by hunted elk could prevent them from optimizing their distribution and habitat selection. Disturbance, therefore, may disrupt herd use of critical winter range and force animals into marginal habitats (Telfer 1978).

The effects of hydrocarbon exploration and development on elk are not well documented in earlier literature, however, limited research in areas of such activities is currently available. Intense exploration and subsequent development produced many hastily planned roads which in conjunction with a vast network of seismic lines resulted in almost unlimited access to critical elk winter range concentration along the Pembina River in Alberta (Smith et al. 1980).



The net result was thought to be a reduction in total elk numbers and a decrease in productivity resulting from displacement of animals from primary range.

Reductions of elk in response to increased access has been documented in several other areas. Johnson and Lockman (1980) found that elk moved their calves at earlier ages in areas where drilling was occurring and avoided meadows which were visible from rig access roads.

Knight (1980) indicated that seismic activity significantly effected the movements but not the distribution of elk in northern Michigan. He further stated that significant increases in elk daily movements may disturb rut and calving activities. In marginal quality habitat sudden movements could possibly place the elk in critical situations.

A study in Alberta by Stubbs, et al. (1979) revealed the impacts of seismic activity of big game winter range. Indications are that helicopters have a very distressing effect on big game and therefore this activity should be kept at a minimum. These researchers recommend:

1. No activity between December 1 and May 1 on ungulate winter ranges.
2. To protect lambing and calving grounds no activity until after July 1.
3. Specific travel lanes should be designated.

Kasworm (1981) felt that timing restrictions for oil and gas activities along the Rocky Mountain Front on mule deer winter ranges should be implemented from December 15 - May 15, migration corridors from May 15 - June 15, and transitional range from October 15 - December 31.

Hoskins (1981) during an elk-seismic study in Wyoming noted that elk at a distance of over 2 miles from the disturbance distributed themselves more at random, while elk within 2 miles of the disturbance used the terrain as a shelter from the activity. Other research in Alberta has indicated that the impact of seismic activity is probably cumulative and where one program might be easily tolerated, numerous projects create considerable impact from line clearing, explosions, machinery, campsites, and concentrated human activity (Telfer 1978). Shared collection of seismic data may be one solution. Kasworm (1981) felt that weather, livestock grazing, housing developments, and recreation in combination with oil and gas development could produce significant changes in mule deer populations.

Stubbs, et al. (1979) summarized the problem, "our approach has been that wildlife and its management is no more important than other renewable and non-renewable resource management - but certainly no less".



Methods

Radio collaring of elk was accomplished by use of a state-owned Bell (4763B-2) helicopter and tranquilizer gun. Animals were immobilized using approximately 22-24 milligrams of succinylcholine chloride dihydrate. Reaction times varied from 2.5-15 minutes. Elk remained immobilized for 45-120 minutes. Tag numbers and neckband descriptions are summarized in Table 1. Movements of two cow elk not subject to seismic disturbance (in the Great Bear Wilderness) approximately 12 miles south of the study area were compared and treated as controls.

An AVM model LA-12 receiver was used as well as AVM transmitters. Receiving antennas were mounted beneath a Piper Supercub aircraft and rotated in the direction of the signal. Locations were plotted on 7.5 minute quadrangle maps. On the ground locations were made using a Telonics RA-2AK two element directional "H" antenna. Three elk were monitored from April through December, 1981, while a fourth elk moved into the area from the Dupuyer-Blackleaf drainages (30 miles southeast) during the summer of 1980 and remained in the Badger area during 1981.

A total of 64 locations of six elk (4 in study area plus 2 in adjacent wilderness) was accumulated from May through November, 1981, with the majority during August and September while seismic blasing occurred. Line locations and working dates were supplied by the U.S.F.S. from seismic company records. Distances between radioed elk and seismic activity were calculated using the closest perpendicular distance to a line, or, if daily activity along that line was identified, then the distance from the activity to the elk (in miles).



Fig. 2 Elk 4-1 under effects of drug. Glacier National Park in background.



TABLE 1

Trapping and tagging information of Two Medicine elk.

Elk #	Date Collared	Location	Collar Description	Ear Tag #'s
3-8	3/13/82	Lubec Ridge, S. Fk. Two Medicine River	<u>2</u>	L.E. A6257 R.E. A6256
4-1	4/18/81	Box Creek, S. Fk. Two Medicine River	<u>1</u>	L.E. A6254 R.E. A6255
4-6	3/26/80	Blackleaf Creek	<u>+++</u>	L.E. A6260 R.E. A6261
4-7	4/18/81	Mettler Coulee, S. Fk. Two Medicine River	<u>5</u>	L.E. A6258 R.E. A6259



Results

Elk 4-1 (an adult cow) was collared in the Box Creek drainage on April 18, 1981. Fourteen relocations have since been plotted on topographic and National Forest maps (see Fig. 3). Seventy percent of the observations of this cow were made during August and September, which coincided with seismic activities on the South Fork Two Medicine River and Badger Creek.

On May 19, cow 4-1 was observed on the west end of Two Medicine Ridge and by June 25 had moved eastward on the ridge to the West Fork of Woods Creek (actual sighting). A July 9 flight found her approximately five miles south of the June location (actual sighting). Seismic activity began in the area on August 1 with SSI line #1 (Seisdata Services, Incorporated). Elk 4-1 was located on the west end of Two Medicine Ridge in heavy timber on August 4, on the opposite side of the ridge and about 1 mile from the nearest source of surface activity (no visual). On August 9, she was found in a basin on the north side of Two Medicine Ridge, again in heavy timber (no visual). This location was approximately 2 miles from seismic activity and out of sight. Activity on SSI lines #2 and 3 was begun on August 14. Elk 4-1 was located August 14, in a heavily timbered area 1.5 miles from the nearest possible ground activity on SSI #1 and two miles from the end of SSI #2 where no activity had yet taken place. SSI lines #1, 2, and 3 were completed by August 19. Elk 4-1 was located in heavy lodgepole timber on August 18, four miles from the nearest activity on SSI #1 and two miles from SSI #2. On August 19, SEFEL line #12 was started and on August 24 elk 4-1 had moved to a heavily timbered area between Rowe Creek and Woods Creek. Activity on SSI #2 had ceased by this time and SEFEL #12 was operative. The cow was within 0.5 miles of SEFEL #12 but the actual ground activity along that line is unknown. On September 1, the elk was tracked to another timbered area 1.5 miles from SEFEL #12 and two drainages south. On September 4, elk 4-1 was sighted at the head of Lost Shirt Creek, near the Continental Divide, two miles and two drainages distant from SEFEL #12. On September 4, SSI #4 was expected to be done shooting in the Badger Cabin vicinity. A September 7 location revealed her less than 0.25 miles from SEFEL #12 which had been finished for approximately 10 days. On September 15, SEFEL #12 was trashed and on September 18, elk 4-1 was four miles south of the helicopter activity and two drainages apart. "Trashing" is a helicopter assisted clean-up procedure after blasting and recording are finished. Trash would include stakes, flagging, or other debris left from the operation.





Mountain Geophysical began line #8 on October 8 and had to abandon their operations early in November because of weather. Elk 4-1 was located on October 21 on the opposite side of Two Medicine Ridge, approximately 3.5 miles from the line. She was found two miles from the inactive line on November 10.



Fig. 4 Upper South Fork Two Medicine River

Elk 4-7, an adult cow, was collared in Mettler Coulee on April 18, 1981, (see Fig. 6). Her next location was in upper Hyde Creek on May 19, near the summit of Mount Pablo on June 25 (visual) and on upper Hyde Creek again on July 9. Most of the locations occurred during August and September in order to gauge the impacts of seismic activity on her summer movements.

Seismic work began on August 1 and on August 4, elk 4-7 had moved out of the Hyde Creek drainage on the opposite side of the ridge from helicopter and blasting activity. Distance to the nearest activity on the seismic line was 5 miles. She was located in the same drainage on August 7, but had moved 6.5 miles away by August 9, as the activity progressed eastward toward her general area.

On August 14, elk 4-7 was sighted near the Continental Divide, 3.5 miles from the closest activity. On this same day SSI lines #2 and 3 were begun in the Whiterock Creek-Mount Pablo area. SSI #1 was finished on August 17 and SEFEL #12 began under Elk Calf Mountain. Elk 4-7 was located in heavy timber near the mouth



of Woods Creek on August 18. SSI lines #2 and 3 were finished on the 17th and 19th of August, respectively, near the Reservation boundary

The elk was observed in upper Lost Shirt Creek on August 25, two drainages south of the activity on SEFEL #12, which by this time had progressed on down Two Medicine Ridge toward her last location. She was approximately 2.5 miles from the nearest seismic work at this time.

On September 4, SSI #4 was expected to finish its shot hole operation and elk 4-7 was located back at the head of Hyde Creek. By this time the blasting activity from SSI lines #1, 2, 3 and SEFEL #12 had subsided.

Elk 4-7 was located in the Hyde Creek drainage again on September 7. SEFEL #12, according to USFS records, was trashed on September 15 and on a September 18 flight she was tracked into the Sydney Creek area, four miles south of the previous two locations.

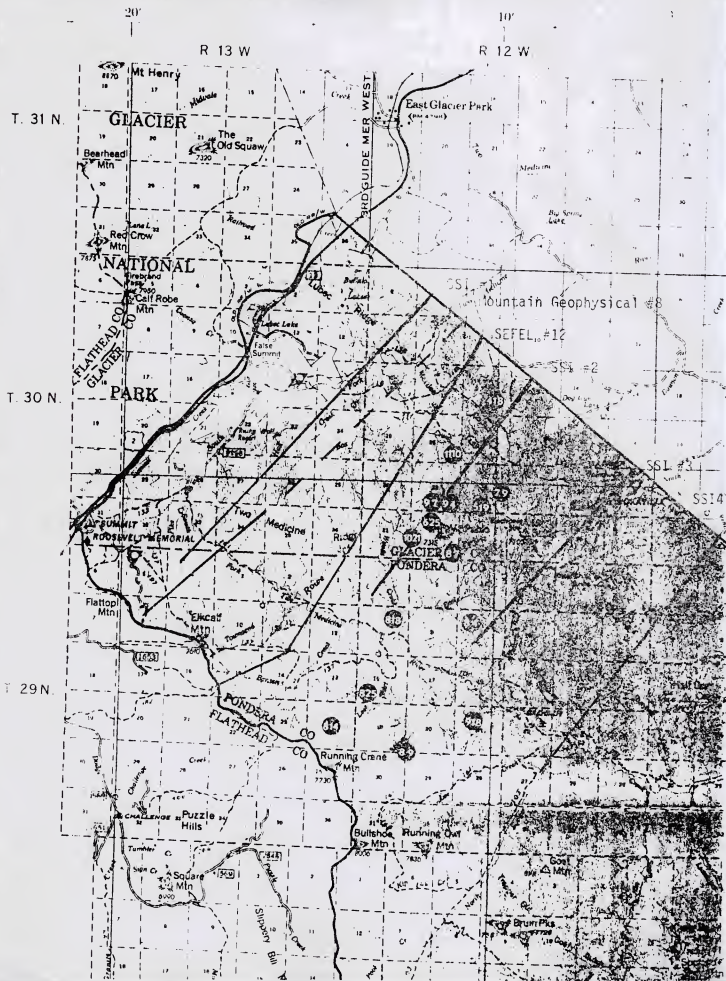
By October 21, elk 4-7 had moved back up on Two Medicine Ridge at the head of Woods Creek, and on November 10 had situated back on Hyde Creek. Mountain Geophysical line #8 was active during portions of October, but shut down for the winter sometime early in November.



Fig. 5 Hyde Creek drainage and Two Medicine Ridge



Fig. 6. Movements of elk 4-7 in relation to seismic activity.





Elk 4-6 was collared March 26, 1980 in Ping's Coulee, approximately two miles north of the Blackleaf Wildlife Management Area (35 miles southeast of study area). April and May, 1980 locations were in the South Fork Dupuyer Creek and Scoffin Butte area. She was not located again until November 12, 1980 in the Badger Creek drainage. Subsequent locations were all in Lee Creek and Badger Creek (Fig. 8).

Seismic activity in the Lee Creek-Badger Cabin vicinity began by about August 10 with SSI lines #3 and 4. Dates and locations of the porta-drill activity on SSI #4 are sketchy, but apparently the line was drilled in segments and not necessarily in sequence from west to east. SSI #3 skirted the northern edge of elk 4-6's known range, while SSI #4 ran up to the east end of her range on Lee Creek.



Fig. 7 Continental Divide at head of Lee and Sydney Creeks

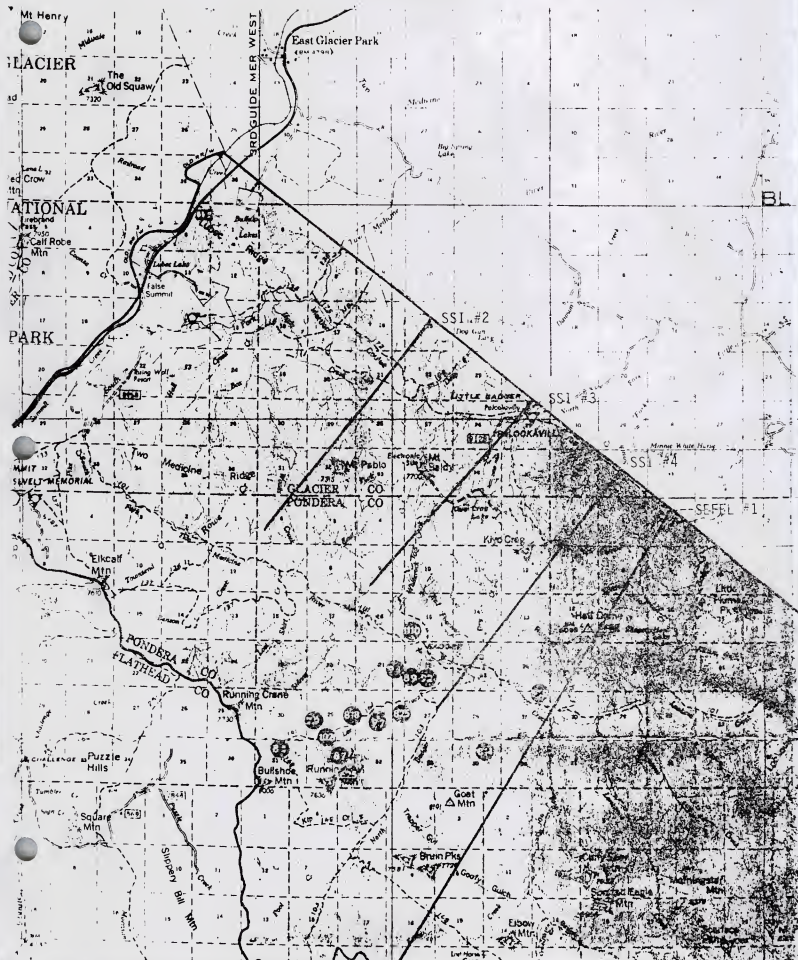
On August 14 she was tracked to an area on the northeast edge of Goat Mountain, a movement that falls in line with the seismic work that began on SSI lines #3 and 4. By August 18 she was back on Lee Creek, but on September 1 she had moved out of Lee Creek into a heavily timbered area just 0.5 miles from Badger Cabin. SEFEL #1, using surface charges, began surveys August 24 and was located northwest of Goat Mountain. This line was also worked from west to east, so it is assumed that by the first week in September the blasting would have



R 13 W

R 12 W

R 11 W





progressed eastward out of the Badger drainage. Elk 4-6 remained in the area south of Badger Cabin until at least September 4, since she was relocated on Lee Creek September 7. On September 18 the 4-6 signal came from a general area between the North Fork Badger Creek and Goat Mountain; a precise location was not obtained. Four days before the opening of the general hunting season she was again back in Lee Creek. A November 10 flight indicated that she had moved into heavy timber between Red Poacher and Whiterock Creeks.

Elk 3-8 was radio collared on Lubec Ridge March 13, 1981, (see Fig. 9). On May 19 she was north of U.S. Highway 2, just east of Lubec Lake, in Glacier National Park. On June 25 elk 3-8 was on upper Railroad Creek, further into the Park. The next flight was on July 9 and she had moved up Railroad Creek to Leena Creek. An August 4 trip into the area revealed that she had moved over Firebrand Pass into the head of Ole Creek. It is about this time that the helicopter and blasting activity began on SSI #1, approximately 2 miles southeast of the Park boundary.

The 25th of August elk 3-8 had moved to an east facing slope on the Old Squaw and spent most of September back on Railroad Creek. She was found on Ole Creek on October 21 and had moved even further down Ole Creek to a basin under Mount Despair by November 10.

Elk 1-2 and 3-7 are adult cows that summer along the Middle Fork Flathead River, in the Great Bear Wilderness, approximately 12 miles south of the study area. Both elk were collared in March, 1979, in roughly the same area as elk 4-6, adjacent to the Blackleaf Wildlife Management Area. Monitoring of these animals movements since 1979 has been less intensive than in the study area. The total number of relocations are listed in Table 2. While no seismic activity has occurred in the Great Bear Wilderness, human activity in the form of hunting is much the same in both areas. The results of the comparison revealed that the movements of elk most likely to be displaced (4-1 and 4-7) actually moved between 30 and 50% more between locations than those in more isolated locations.

Movements of elk 4-6 are not as easily related to seismic work as those of 4-1 and 4-7, probably because the Lee Creek drainage is more isolated than others and because seismic lines were not surveyed through her summer use area as they were in the case of the other two elk. Nonetheless, trends of movements do correlate with the timing of seismic activity and do support evidence gained in the study of 4-1 and 4-7.



Fig. 9. Movements of elk 3-8 in relation to seismic activity.

R. 15 W.

R. 14 W.

R. 13 W.

T. 31 N.

T. 30 N.

29 N.

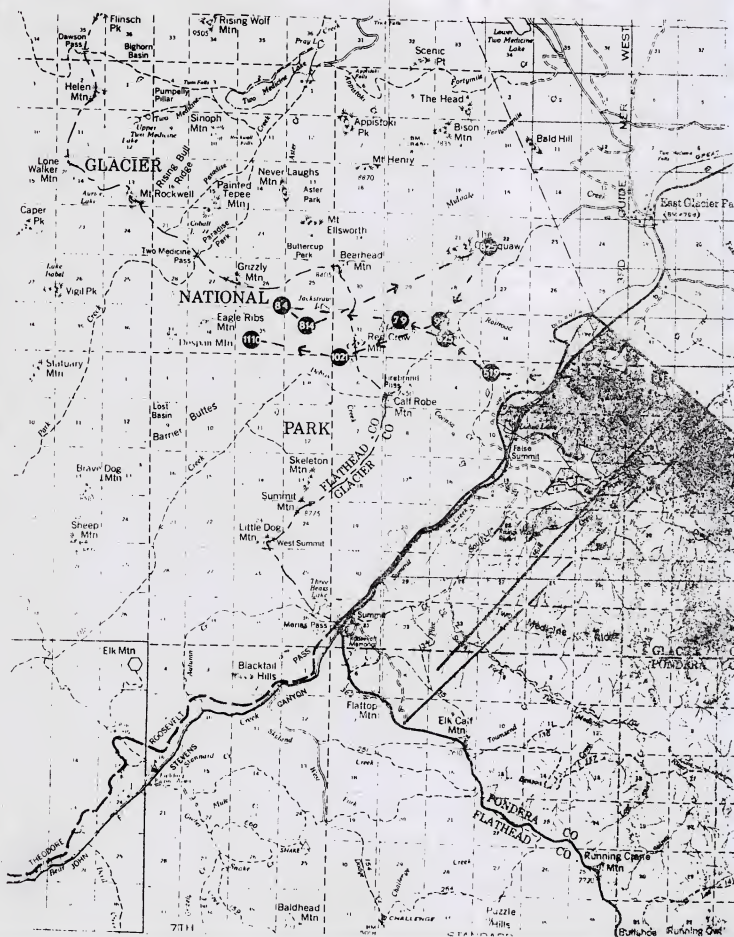




TABLE 2

Comparison of elk movements on two different summer ranges in relation to seismic activity

Elk #	Ave. Movement Between Relocations	Number of Relocations	Frequency of Relocation	Summer Range Area
1-2	1.72 miles	19	0.6/ mo.	Middle Fork Flathead River Great Bear Wilderness (No Seismic Activity)
3-7	1.98 miles	14	0.4/ mo.	" "
3-8	1.88 miles	8	2.0/ mo.	Glacier National Park
4-1	3.05 miles	13	3.0/ mo.	South Fork Two Medicine River
4-6	1.71 miles	14	3.2/ mo.	North Fork Badger Creek
4-7	2.56 miles	12	3.0/ mo.	South Fork Two Medicine River



Although no seismic work occurred within Glacier National Park SSI #1 was close enough to the boundary to have an effect on elk 3-8, and a movement out of the area did in fact occur sometime in late July or early August. It is possible that the sight or sound of helicopters or blasting may have pushed her over Firebrand Pass.

Figure 10 shows movements of elk 4-1 and 4-7 before, during, and after seismic activity. Why 4-1 made a long trip from Two Medicine Ridge to the Continental Divide early in July is unknown. No seismic work had yet taken place. Possibilities include illegal harassment by aircraft, movement of cattle into the area the last week in June, and a one day moto-cross race that was held July 12. Preparations for the race took place in June and numerous "runs" over the course with bikes were needed to mark trails, etc. This reasoning is purely speculative, especially, since data from the previous summer was not obtained on any of the four elk.

After August 1, elk movements began to follow a pattern of avoidance to helicopters and explosives until late September when activity subsided. It is interesting that on September 15, SEFEL #12 was trashed. On September 18 both elk had moved 2-4 miles from their previous locations on the vacated line; by October 23 they were back in the area of the abandoned line. Summering elk in the Two Medicine drainage apparently have a great affinity for certain habitat types and locations, as is indicated by their willingness to relocate in such areas after seismic work was finished. The data suggests that a few days of activity is tolerated but when that time limit is exceeded elk begin a series of movements to avoid the disturbance.

Discussion

Analysis of movements of four radio collared elk in the Badger-Two Medicine drainages from May through November, 1981, indicates a tendency to avoid visual disturbances rather than auditory signals, at least initially. Seismic blasting could be heard in all drainages of the study area during August, however, elk movements appeared to be more related to visual barriers between them and human activity. The average distance moved between relocations is presented in Table 2. Elk 4-7 showed similar tendencies to 4-1 in relation to movements in areas where seismic blasting occurred. Distances moved by both elk increased as the disturbance approached areas that they frequented.

Wintering big game species, especially elk, in the Two Medicine-Badger drainages are severely limited, both by time and space. Year round illegal hunting may cause excessive energy expenditures due to induced avoidance behavior.



Foraging areas that are relatively inaccessible by humans are few. Fortunately, forage quality is good and wintering elk make use of these windswept rough fescue openings. It is interesting to note that while summering elk are in areas adjacent to grazing allotments not one relocation was made where the two intermingled. Winter habitat is generally occupied after cattle are removed from the forest.

The quality of forage for wintering elk is directly related to successful reproduction. Thorne, et al. (1976) found that in Wyoming elk, a calf that was born weighing approximately 16 kg. or more at birth would have a 90% chance of survival to one month of age. Chances for survival fell below 50% when calf weights were less than 11.4 kg. Energy expenditures during winter months are critical to elk and any additional disturbances result in an energy deficit, both to the cow and her fetus. In severe cases herd productivity suffers with total population levels falling within a few years. Considering the amount of human activity in this area, it is apparent that some degree of regulation may be necessary to insure a viable, healthy elk herd.

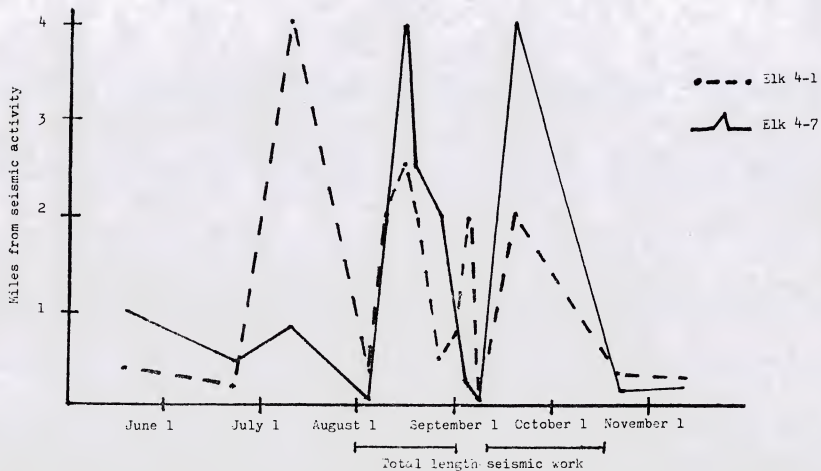
Winter activity should be kept at a minimum. Illegal hunting is a problem which will likely persist, and, even though the entire wintering herd is not affected at the same time, movements to avoid these activities may be very costly (energy-wise) to the whole population. It is recommended that no seismic exploration be allowed on winter foraging areas or adjacent thermal cover from November 1 - May 1. These dates provide flexibility for elk to deal with hunters, winter conditions, and early calving periods. Disturbance on known calving grounds and spring migration zones should be prevented from May 1 - June 30. This will insure that calving elk and those migrating with calves will be able to establish on summer ranges before seismic activity begins.

Specific travel routes should be designated for aircraft and work crews to minimize "cut across" traffic between lines. Helicopters in flight should maintain a 500 foot elevation above valley bottoms, sideslopes and passes. In areas of goat and sheep concentrations timberline areas and above should be avoided as much as possible with no hovering or low altitude passes in selected alpine zones (Joslin, 1981). It is suggested that these travel routes be no more than 0.5 miles wide.

A distance of at least one main river drainage or three tributary drainages should be maintained between concurrent seismic lines. The South Fork Two



Fig. 10. Movements of two cow elk in relation to seismic blasting and associated activities.





Medicine River would be defined as a main drainage, with Sydney Creek, for example, serving as a tributary stream. Lines running transversely to the direction of streams or drainages could be handled in a manner which would allow at least 5 miles between concurrent lines, making sure that adequate visual barriers were available.

Aldo Leopold (1933) put it very neatly, "control is the combination of science and use". Therefore, in order to fully understand the complexities of our resources we need to integrate management theory with resource use. Hopefully, impact studies such as this one will contribute something towards that end.



Literature Cited

1. Basile, J. V., and T. Lonner. 1979. Vehicle restrictions influence elk and hunter distribution in Montana. Jour. Forestry. 77(3):155-159.
2. Black, H., R. Scherzinger, J. W. Thomas. 1975. Relationships of Rocky Mountain elk and Rocky Mountain mule deer habitat to timber management in the Blue Mountains of Oregon and Washington. Pages 11-31. In S. R. Hieb, ed. Proc. elk-logging roads. Symposium. University of Idaho. 142pp.
3. Greull, G. E., and G. Roby. 1975. Elk habitat relationships before logging on Bridger-Teton National Forest, Wyoming. Pages 110-121. In S. R. Hieb, ed. Proc. elk-logging-roads symposium. University of Idaho. 142pp.
4. Hershey, T. J., and T. A. Leege. 1975. Influence of logging on summer range in northcentral Idaho. Pages 73-80. In S.R. Hieb, ed. Proc. elk-logging-roads symposium. University of Idaho. 142pp.
5. Hoskins, W. P. 1981. Effects of portable seismic exploration activities on wintering large mammals, primarily elk in northwestern Wyoming. Draft Copy only, Mile High Explorations, Jacson, Wyo. 41pp.
6. Johnson, B. K., and D. Lockman. 1981. Response of elk during calving to oil/gas activity in Snider Basin, Wyoming. Wyoming Fish and Game Dept. 12pp.
7. Joslin, G. 1981. Personal communication, Nov. 12, 1981
8. Kasworm, W. F. 1981. Distribution and population characteristics of mule deer along the East Front, northcentral Montana. Unpubl. M.S. Thesis. Montana State University, Bozeman, MT 73pp.
9. Knight, J. E. Jr. 1980. Effect of hydrocarbon development on elk movements and distribution in northern Michigan. Unpubl. PhD Thesis. University of Michigan, Ann Arbor, Michigan.
10. Leopold, A. 1933. Game Management. Charles Scribner's Sons. 481pp.
11. Lonner, T. 1981. Elk/timber management relationships for Easside Forests of the Northern Region, U.S.F.S. Montana Dept. Fish, Wildlife & Parks. Draft Copy. 31pp.
12. Lyon, L. J. 1975. Elk use as related to characteristics of clear-cuts in western Montana. Pages 69-72. In S. R. Hieb, ed. Proc. elk-logging-roads symposium. University of Idaho. 142pp.
13. Marcum, C. L. 1967. Habitat selection and use during summer and fall months by a western Montana elk herd. Pages 91-96. In S. R. Hieb, ed. Prec. Elk-logging-roads symposium. University of Idaho 142pp.
14. Montana Elk-Logging Research Committee, E. Schneegas, Chairman. 1981. Elk management recommendations for the consideration of land managers. Montana Cooperative Elk-Logging Study. Annual Progress Resport. 90pp.

15. Morganti, L. E. 1979. Habitat selection and resource division among bighorn sheep, elk, and mule deer in Western Alberta. M.S.C. Thesis. University of Alberta 187pp.
16. Perry, C. A. and R. Overly. 1977. Impact of roads on big game distribution in portions of the Blue Mountains of Washington, 1972-73. Washington Game Dept. Bull. No 11. 38pp.
17. Roberts, H. B. 1974. Effects of logging on elk calving habitat, Moyer Creek, Salmon National Forest, Idaho. U.S.D.A: Forest Serv. Salmon Nat'l Forest Salmon, Idaho. 22pp.
18. Rost, G. R. and J. A. Baily 1979. Distribution of mule deer and elk in relation to roads. J. Wildlife Management 43(3):634-641
19. Schallenberger, A. 1974. Wildlife habitat report, Badger Creek-Two Medicine Management Unit. U.S.F.S. Unpubl. report 50pp.
20. Smith, K. and M. Bloomfield. 1980. Strategy for elk management during a period of intense oil and gas activity. From: Proceedings of the Western States Elk Workshop, Feb. 27-28, 1980. Cranbook, B.C. 174pp.
21. Stubbs, C. W. and B. J. Markham. 1979. Wildlife mitigative measures for oil and gas activity in Alberta. From: Mitigation Symposium, Fort Collins, Co. July 16-20
22. Telfer, E. 1978. Cervid distribution, browse, and snow cover in Alberta. J. Wildlife Management 42(2):352-361
23. Thorne, E. T., R. E. Dean, and W. G. Hepworth. 1976. Nutrition during gestation in relation to successful reproduction in elk. J. Wildlife Management 40(2):332-335.
24. Ward, A. W. 1975. Elk behavior in relation to timber harvest operations and traffic on the Medicine Bow Range in southcentral Wyoming. Pages 32-43. In S. R. Hieb, ed. Proc. elk-logging-roads symposium. University of Idaho 142pp.

